

**545oneDrive2\_00020250**

# EPAct Program Update for DOE

Status and Budget

March 4, 2009

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1

## **Status of Testing and Fuel Blending**

- Phase 1 testing complete
  - 75°F testing of 19 vehicles on 3 fuels (E0, E10, E15)
- Interim FTP-cycle testing complete
  - 75°F testing of 6 vehicles on 3 fuels (E0, E10, E15)
- Phase 2 testing complete
  - 50°F testing of 19 vehicles on 3 fuels (E0, E10, E15)
- Currently preparing to launch Phase 3 (main fuel matrix) with reduced scope due to uncertain funding
  - 75°F testing of 10? (originally 19) vehicles on 26 fuels (E0, E10, E15, E20)
- Test fuel development being done by Haltermann and ASD
  - EPA defines fuel recipes
  - Haltermann prepares hand blends, bulk blends and performs fuel analyses
- 22 of the 26 fuels needed in Phase 3 have been blended in bulk
  - 13 have been delivered to SWRI

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2

### Test Results to Date

- Preliminary Results for 75°F
  - Decrease in cold start NOx for E10 and E15 compared to E0
    - No statistically significant change in overall NOx emission for composite drive cycle
  - Decrease in CO and HC emissions in composite drive cycle
  - PM results are mixed, no clear trends
  - Acetaldehyde and ethanol emissions increase with fuel ethanol level
  - Findings are consistent with DOE's mid-level blends report

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3

### **Phase 1 Criteria Emission Impacts**

(Categorical Analysis via Mixed Model,  $p \leq 0.05$  or  $p \leq 0.10$ )

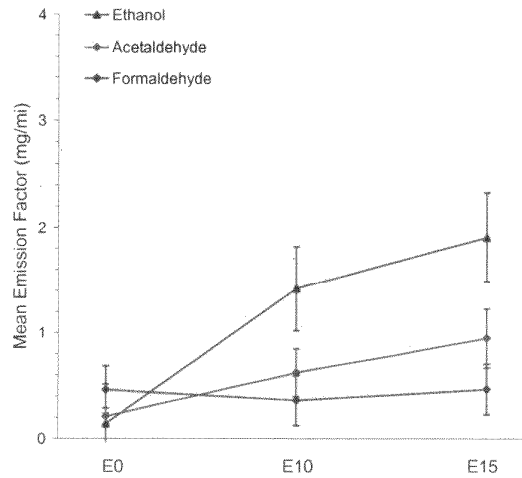
| E10 vs. E0 Relative Difference (%) |       |       |       |       | E15 vs. E0 Relative Difference (%) |       |       |       |      |
|------------------------------------|-------|-------|-------|-------|------------------------------------|-------|-------|-------|------|
|                                    | Bag 1 | Bag 2 | Bag 3 | Comp  | Bag 1                              | Bag 2 | Bag 3 | Comp  |      |
| NOx                                | -21.6 |       |       |       | -18.3                              |       |       |       |      |
| THC                                | -11.1 |       | -27.8 | -10.2 |                                    |       |       |       | -9.8 |
| CO                                 | -14.6 |       | -35.6 | -13.8 | -16.4                              |       | -30.5 | -13.3 |      |
| NMHC                               | -13.3 |       | -38.1 | -12.8 |                                    |       | -35.4 | -14.5 |      |
| CO2                                | -1.5  | -1.3  | -1.0  | -1.3  | -0.8                               | -0.9  | -0.6  | -0.9  |      |
| PM                                 |       | -17.3 | 30.4  |       | 24.8                               |       | 59.4  |       |      |

| E15 vs. E10 Relative Difference (%) |       |       |       |      |
|-------------------------------------|-------|-------|-------|------|
|                                     | Bag 1 | Bag 2 | Bag 3 | Comp |
| NOx                                 |       |       |       |      |
| THC                                 |       |       |       |      |
| CO                                  |       |       |       |      |
| NMHC                                |       |       |       |      |
| CO2                                 |       | 0.7   |       | 0.4  |
| PM                                  |       | 21.9  |       | 18.5 |

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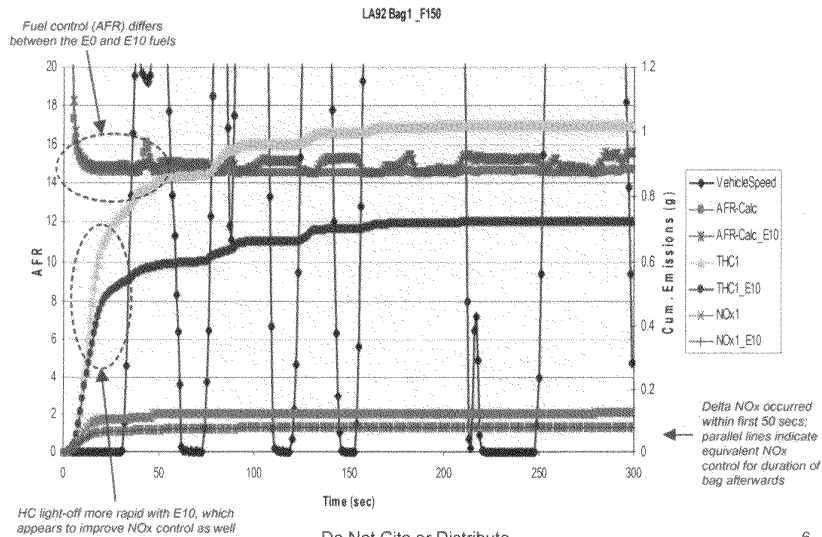
### Effects on Key Toxics



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### Example of modal and OBD data showing source of emissions changes between E0 and E10 fuels for one vehicle



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### Caveats to Phase 1 Results

- Phase 1 fuels were chosen to approximately represent how in-use ethanol blends might look in an RFS2 world
  - Goal was to get a preview of ethanol impacts for RFS2 proposal
- However, **multiple properties change between these fuels besides ethanol level**
  - Resulting dataset cannot be used to assign quantified emission effects to ethanol specifically without the rest of the data from Phase 3
  - Meaningful fuel effects modeling cannot be done using resulting dataset alone

| PROPERTY        | UNIT   | METHOD | FUEL |      |      |
|-----------------|--------|--------|------|------|------|
|                 |        |        | E0   | E10  | E15  |
| Ethanol Content | vol. % | D5599  | <0.1 | 9.35 | 14.5 |
| T50             | °F     | D86    | 215  | 209  | 182  |
| T90             | °F     | D86    | 324  | 319  | 310  |
| RVP             | psi    | D5191  | 9.17 | 9.05 | 8.91 |
| Aromatics       | vol. % | D1319  | 29.3 | 22.9 | 18.7 |
| Olefins         | vol. % | D1319  | 6.4  | 5.7  | 5.6  |
| Benzene         | vol. % | D3606  | 0.48 | 0.49 | 0.46 |
| S               | mg/kg  | D5453  | 23   | 23   | 21   |
| RON             | -      | D2699  | 93.4 | 93.7 | 93.9 |
| MON             | -      | D2700  | 83.5 | 84.9 | 84.6 |
| (R + M)/2       | -      | Calc.  | 88.5 | 89.3 | 89.2 |

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### Budget Considerations Going Forward

- Current program cost estimates significantly exceed original projections
  - Unrealistically low original cost estimates by SWRI
    - Underestimation of base program cost: Ex. 4 - CBI
      - Base program cost estimate went up by Ex. 4 - CBI between January 7, 2009 and February 5, 2009
      - Unexpectedly high cost of "coming up to speed": Ex. 4 - CBI
      - Additional checkout tests to resolve HC analyzer saturation and secondary dilution ratio issues in Phase 2: Ex. 4 - CBI
      - Higher than originally estimated test replication rate: Ex. 4 - CBI
  - Fuel cost increase (modified fuel development protocol): Ex. 4 - CBI
  - Additional tasks:
    - EFM resolution: Ex. 4 - CBI
    - Fuel matrix redesign: Ex. 4 - CBI
    - FTP testing: Ex. 4 - CBI
- Current shortfall: Ex. 4 - CBI

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### Options to Reduce Cost

- Delay testing of CRC fuels: \$195,000
  - Reduce the number of test fuels
    - Reduction of the number of fuels by 1 would drop the G-efficiency of emission models below the minimum acceptable limit of 50%
      - Coverage drops, fuel effects become confounded very fast
  - Reduce the number test vehicles
    - Reduction of the number of vehicles from 19 to 15 doubles the probability of getting a non-significant result in emission models. The power of the statistical test of 0.80 is the lowest acceptable in std practice (0.95 was used in AutoOil)
    - Reducing the number of test replicates from 2 to 1 has an even stronger impact
  - Eliminate continuous THC, NOx.... measurements in raw exhaust
    - Would make critical types of information unavailable
    - Minimal savings
  - Reduce the scope of exhaust HC speciation
    - Data necessary for AQ modeling and toxic emission factors
      - Phase I and II data not adequate due to fuel blending problems
  - Work with SWRI to reduce program cost
  - Obtain additional EPA funds
  - Request additional DOE support
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10 goes to 0.7

- 30-40K

- Ferry Dist

**EPA Act Cost Estimator**

| Item  | Cost | Comments |
|---|------|----------|
| Cost of Phase 3 (lower limit) - EPA estimate  |      |          |
| Funds currently available from the EPA  |      |          |
| Additional funds from EPA   |      | TBD      |
| Funds "released" by DOE due to reduced scope of Phase 3                               |      |          |
| Additional funds from DOE   |      | TBD      |
| Scaling back of the number of vehicles to 15  |      |          |
| Scaling back of exhaust HC speciation by 50%  |      |          |
| Elimination of continuous THC, NOx..... measurements in raw exhaust                   |      | minimal  |
| <b>Total</b>  |      |          |
| Additional funding needed to test 15 vehicles while scaling back HC speciation by 50% |      |          |

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# Back-up Slides

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11

## Revised EPA Act Fuel Matrix

**Phase 3**  
**Base Program (EPA)**  
**(Fuels 1-16)** →

**Phases 1 and 2**  
**RFS 2 Subset (EPA/DOE)**  
**(Fuels 17-19)** →

**Phase 3**  
**Additional Fuels (DOE)**  
**(Fuels 20-29)** →

**E85 (DOE)** →  
**CRC Additional Fuels** →

| Fuel # | T50 | T90 | ETOH | RVP | ARO |
|--------|-----|-----|------|-----|-----|
|        | °F  | °F  | %    | psi | %   |
| 1      | 150 | 300 | 10   | 10  | 15  |
| 2      | 240 | 340 | 0    | 10  | 15  |
| 3      | 220 | 300 | 10   | 7   | 15  |
| 4      | 220 | 340 | 10   | 10  | 15  |
| 5      | 240 | 300 | 0    | 7   | 40  |
| 6      | 190 | 340 | 10   | 7   | 15  |
| 7      | 190 | 300 | 0    | 7   | 15  |
| 8      | 220 | 300 | 0    | 10  | 15  |
| 9      | 190 | 340 | 0    | 10  | 40  |
| 10     | 220 | 340 | 10   | 7   | 40  |
| 11     | 190 | 300 | 10   | 10  | 40  |
| 12     | 150 | 340 | 10   | 10  | 40  |
| 13     | 220 | 340 | 0    | 7   | 40  |
| 14     | 190 | 340 | 0    | 7   | 15  |
| 15     | 190 | 300 | 0    | 10  | 40  |
| 16     | 220 | 300 | 10   | 7   | 40  |
| 17     | 215 | 325 | 0    | 9   | 30  |
| 18     | 202 | 325 | 10   | 9   | 25  |
| 19     | 195 | 325 | 15   | 9   | 23  |
| 20     | 160 | 300 | 20   | 7   | 15  |
| 21     | 160 | 300 | 20   | 7   | 40  |
| 22     | 160 | 300 | 20   | 10  | 15  |
| 23     | 160 | 340 | 20   | 7   | 15  |
| 24     | 160 | 340 | 20   | 10  | 15  |
| 25     | 160 | 340 | 20   | 10  | 40  |
| 26     | 150 | 340 | 15   | 10  | 40  |
| 27     | 190 | 340 | 15   | 7   | 15  |
| 28     | 190 | 300 | 15   | 7   | 40  |
| 29     | TBD | TBD | 85   | TBD | TBD |
| 30     | 150 | 325 | 10   | 10  | 40  |
| 31     | 160 | 325 | 20   | 10  | 15  |

Revised Fuels

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12

### **Projected Schedule Going Forward**

- Launch of Phase 3 testing: Mid-February 2009
- Completion of Phase 3 testing: Early December 2009
- Reporting: December 2009 – mid-March 2010

|                    |          | JAN 2009   | FEB 2009  | MAR 2009      | APR 2009   | MAY 2009    | JUN 2009       | JUL 2009          | AUG 2009      | SEP 2009   | OCT 2009          | NOV 2009     | DEC 2009   |
|--------------------|----------|------------|-----------|---------------|------------|-------------|----------------|-------------------|---------------|------------|-------------------|--------------|------------|
|                    |          | 5 12 19 26 | 2 9 16 23 | 2 9 16 23 30  | 6 13 20 27 | 4 11 18 25  | 1 8 15 22 29   | 6 13 20 27        | 3 10 17 24 31 | 7 14 21 28 | 5 12 19 26        | 2 9 16 23 30 | 7 14 21 28 |
| Phase 1*           | 14 weeks |            |           |               |            |             |                |                   |               |            |                   |              |            |
| SOF setup          | 3 weeks  |            |           |               |            |             |                |                   |               |            |                   |              |            |
| Phase 2*           | 9 weeks  |            |           |               |            |             |                |                   |               |            |                   |              |            |
| SOF teardown       | 2 weeks  |            |           |               |            |             |                |                   |               |            |                   |              |            |
| Phase 3*           | 26 weeks |            |           | 1 2 3 4 5 6 7 | 8 9 10 11  | 12 13 14 15 | 16 17 18 19 20 | 21 22 23 24 25 26 |               |            |                   |              |            |
| NREL tests*        | 17 weeks |            |           |               |            |             |                |                   | 1 2 3 4 5 6 7 | 8 9 10 11  | 12 13 14 15 16 17 |              |            |
| CRC tests          | 4 weeks  |            |           |               |            |             |                |                   |               |            |                   |              | 1 2 3      |
| NREL high emitter  | 2 weeks  |            |           |               |            |             |                |                   |               |            |                   |              | 1 2 3      |
| draft final report | 6 weeks  |            |           |               |            |             |                |                   |               |            |                   |              |            |
| EPANREL review     | 4 weeks  |            |           |               |            |             |                |                   |               |            |                   |              |            |
| final report       | 4 weeks  |            |           |               |            |             |                |                   |               |            |                   |              |            |

|                    |          | JAN 2010   | FEB 2010  | MAR 2010     | APR 2010   | MAY 2010   | JUN 2010     | JUL 2010   | AUG 2010      | SEP 2010   | OCT 2010   | NOV 2010     | DEC 2010   |
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| CRC tests          | 4 weeks  |            |           |              |            |            |              |            |               |            |            |              |            |
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| draft final report | 6 weeks  |            | 4 5 6     |              |            |            |              |            |               |            |            |              |            |
| EPANREL review     | 4 weeks  |            | 1 2 3 4   |              |            |            |              |            |               |            |            |              |            |
| final report       | 4 weeks  |            |           | 1 2 3 4      |            |            |              |            |               |            |            |              |            |

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13